Electronic Version
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Claims

[c1] A method of manufacturing an integrated circuit comprising:
providing a target design, wherein said target design has an target image shape divided into target segments and each of said target segments has an associated segment evaluation point;
providing an initial mask shape;
dividing said mask shape into mask segments corresponding to each of said target segments;
determining a simulated image corresponding to each of said associated segment evaluation points, wherein said simulated image is formed in accordance with said mask shape for a lithographic process;
providing a deviation tolerance for a deviation of a simulated image metric from a corresponding target image metric; and
for each of said segment evaluation points,
determining a simulated image metric based on said simulated image at said segment evaluation point, and
refining the mask segment corresponding to said segment evaluation point if said simulated image metric exceeds said deviation tolerance.

[c2] The method of claim 1, wherein said deviation tolerance comprises a maximum distance of a threshold intensity contour of a simulated image from a threshold intensity contour of a target image.

[c3] The method of claim 1, wherein said step of determining a simulated image metric further comprises determining an estimated image based on said simulated image corresponding to said segment evaluation points.

[c4] The method of claim 3, further comprising determining said estimated image by a curve fit based on said simulated image corresponding to said segment evaluation points.

[c5] The method of claim 4 wherein said curve fit is performed by a method selected from the group consisting of Binomial spline, polygonal approximation, circular arc, cubic spline and Bezier curve.

[c6] The method of claim 1 further comprising the step of determining a simulated image further comprises determining an image intensity, a gradient and curvature of said simulated image intensity corresponding to said segment evaluation point.

[c7] The method of claim 6 further comprising:

providing a gradient tolerance and a curvature tolerance; and

testing said gradient, and

if said gradient is not equal to zero and is less than or equal to said gradient tolerance, or if said gradient is equal to zero and said curvature is less than or equal to said curvature tolerance, then skipping said step of refining the mask segment.

[c8] The method of claim 6 further comprising:

providing a gradient tolerance and a curvature tolerance; and

testing said gradient, and

if said gradient is not equal to zero and is greater than said gradient tolerance, or if said gradient is equal to zero and said curvature is greater than said curvature tolerance, then determining an estimated image based on said simulated image corresponding to said segment evaluation point.

[c9] The method of claim 8, wherein said determining an estimated image further comprises a curve fit based on said simulated image corresponding to said segment evaluation points.

[c10] The method of claim 9, wherein said curve fit is performed by a method selected from the group consisting

of Binomial spline, polygonal approximation, circular arc, cubic spline and Bezier curve.

[c11] A computer program product comprising:
a machine readable medium having machine readable program code means embodied therein, the computer readable program code means comprising instructions executable by the machine to perform methods steps for designing a lithographic mask, said method steps comprising:
storing a target design, wherein said target design has an target image shape divided into target segments and each of said target segments has an associated segment evaluation point;
storing an initial mask shape;
dividing said mask shape into mask segments corresponding to each of said target segments;
determining a simulated image corresponding to each of said associated segment evaluation points, wherein said simulated image is formed in accordance with said mask shape for a lithographic process;
storing a deviation tolerance for a deviation of a simulated image metric from a corresponding target image metric; and
for each of said segment evaluation points,
determining a simulated image metric based on said

simulated image at said segment evaluation point, and refining the mask segment corresponding to said segment evaluation point if said simulated image metric exceeds said deviation tolerance.

[c12] The computer program product of claim 11, wherein said deviation tolerance comprises a maximum distance of a threshold intensity contour of a simulated image from a threshold intensity contour of a target image.

[c13] The computer program product of claim 11, wherein said step of determining a simulated image metric further comprises determining an estimated image based on said simulated image corresponding to said segment evaluation points.

[c14] The computer program product of claim 13, further comprising determining said estimated image by a curve fit based on said simulated image corresponding to said segment evaluation points.

[c15] The computer program product of claim 14 wherein said curve fit is performed by a method selected from the group consisting of Binomial spline, polygonal approximation, circular arc, cubic spline and Bezier curve.

[c16] The computer program product of claim 11 further comprising the step of determining a simulated image fur-

ther comprises determining an image intensity, a gradient and curvature of said simulated image intensity corresponding to said segment evaluation point.

[c17] The computer program product of claim 16 further comprising:
storing a gradient tolerance and a curvature tolerance; and
testing said gradient, and
if said gradient is not equal to zero and is less than or equal to said gradient tolerance, or if said gradient is equal to zero and said curvature is less than or equal to said curvature tolerance, then skipping said step of refining the mask segment.

[c18] The computer program product of claim 16 further comprising:
storing a gradient tolerance and a curvature tolerance; and
testing said gradient, and
if said gradient is not equal to zero and is greater than said gradient tolerance, or if said gradient is equal to zero and said curvature is greater than said curvature tolerance, then determining an estimated image based on said simulated image corresponding to said segment evaluation point.

[c19] The computer program product of claim 18, wherein said determining an estimated image further comprises a curve fit based on said simulated image corresponding to said segment evaluation points.

[c20] The computer program product of claim 19, wherein said curve fit is performed by a method selected from the group consisting of Binomial spline, polygonal approximation, circular arc, cubic spline and Bezier curve.